

Evaluating the impact of Change Orders on Construction Projects in Oman

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ABSTRACT

Most of the construction projects are subject to change as some projects need to make some changes and modifications to the design, specifications, or any other work. These changes may be small and do not affect the duration and cost of the project, and they may be significant, resulting in increased working life and cost. Changes in construction projects have become a common and widespread phenomenon in Oman, with most government projects facing cost and time increases due to change orders. In this study, this problem was highlighted and the necessary solutions were found. The aim of this study was to assess the effect of change orders on construction projects and their causes. In order to achieve the aim of the study, the Governorate of Muscat was determined to conduct the study in it. This study was conducted on the basis of a literature review and several methods were used to collect information and data to obtain accurate results. Interviews were conducted with all parties (clients, contractors, and consultants), and the questionnaire was also distributed electronically to 215 engineers in the private and government sectors and qualitative data (interviews) were analyzed by using the Constant Comparative method, as for quantitative data (questionnaire) by SPSS program. The research revealed many results, the most prominent of which is that change orders have a major role in increasing the duration and cost of the project. Finally, some recommendations were proposed that could contribute to the development of Omani projects and reduce the issuance of change orders.

Introduction

The construction business is probably the most seasoned area of the Oman economy and is liable for assembling a sizable measure of capital and assets. The two most noticeable customers in the construction business are private proprietors and offices in the public area. As opposed to framework projects that are intensely overwhelmed through the public area, private proprietors are more associated with the construction of private, business, and mechanical structures. In any case, with regards to the development and redesign of school structures, government-funded school areas are included. The development strategies utilized through the customers for business and public undertakings do not contrast in nature; nevertheless, project financing, obtainment, and the task prioritization measure vary in certain viewpoints (Tunji-Olayeni et al. 2016). Change orders are regular issues in development projects, and the impact of progress orders on expense and timetable is examined in this study. Notwithstanding, not many examinations have thought about the impact of progress orders on expense and timetable overwhelms building redesign projects in Oman. The investigation of progress orders is basic since it has suggestions for legitimate issues just as questions on any undertaking. In case that there are no progressions or few changes on a venture, legitimate issues and debates identified with postpone claims are decreased. On most activities, questions happen after the proprietors digress from the first agreement regarding configuration change, amount varieties, proprietor started changes, or changes because of unexpected conditions. At times, these progressions become debates and can go to suit if the change orders are not overseen productively and fittingly. Thusly, it is important to decide if the undertaking conveyance technique has any effect on change orders to lessen questions and cases among proprietors and temporary workers (Besson and Lasnier 2020).

Overview of Change Orders:

The hard nature of projects of construction makes it hard to complete any development project without changing the plans or the process of development itself. A typical practice in the development business is project-based. When all is said in done, a construction project incorporates numerous stages from arranging, structural drawings, and designing plans, cost assessment, offering, and contracting to the real execution of the venture. During these stages, numerous choices must be made dependent on inadequate data, presumptions, and individual experience of the development experts. Whatever the size of the undertakings, development sizes can fluctuate broadly, and they will in general have one normal fixing - 'change'. Changes are exceptionally normal. Also it is probably going to happen at any phase of development, and this has driven numerous scientists to declare that for all development projects, there are 13 changes. An unavoidable truth. Likewise, project changes or potential adjustments are inescapable because they speak to an unavoidable truth in all phases of the undertaking life cycle. Changes may happen for different reasons, for example, adjustment of extension, timetable, expenses, and strategies. Change orders are one of the principal reasons why a venture's predetermined time is not met. Change orders should be control viably. Something else, clashes may emerge between all venture members.

Factors impact change orders in construction projects

Labor Productivity

It in construction is frequently comprehensively characterized as yield per work hour. Since work establishes an enormous portion of the construction cost and the quantity of work hours in playing out an undertaking in development is more powerless to the impact of the executives than are materials or capital, this efficiency measure is regularly alluded to as work profitability. In any case, note that work profitability is a proportion of the general adequacy of a working framework in using work, gear, and money to changing overwork endeavors into helpful yield, and isn't a proportion of the capacities of work alone. For instance, by putting resources into a bit of new hardware to play out specific undertakings in construction, the yield might be expanded for a similar number of work hours, subsequently bringing about higher work profitability (Hanna et al. 2002).

Construction Equipment

The choice of the fitting kind and size of construction gear frequently influences the necessary measure of time and exertion and in this way the place of work efficiency of a task. It is in this way significant for site supervisors and Construction organizers to be acquainted with the qualities of the significant kinds of hardware most ordinarily utilized in development (Hanna et al. 2002).

Materials Management

It is a significant component in task arranging and control. It displays a significant cost in construction, so limiting obtainment or buy costs presents significant open doors for diminishing expenses. Helpless materials for the executives could bring about enormous and avoidable expenses during development. To start with, if materials are bought early, capital might be tied up and interest charges acquired on the overabundance stock of materials. Much more dreadful, materials may decay during capacity or be taken except if unique consideration is taken. For instance, electrical hardware regularly should be put away in waterproof areas. Second, deferrals and additional costs might be caused if materials needed for specific exercises are not accessible. Appropriately, guaranteeing an ideal progression of material is a significant worry of undertaking directors. It isn't only a worry during the checking stage in which

construction is occurring. Choices about material acquisition may be needed during the underlying arranging and planning stages (Hanna et al. 2002).

Construction Processes

The past segments depicted the essential contributions of work, material, and gear to the Construction process. At different degrees of detail, a venture chief must guarantee that these sources of info are viably planned to accomplish an effective Construction measure. This coordination includes both key choices and strategic administration in the field. For instance, key choices about fitting innovations or site design are regularly made during the cycle of development arranging. Throughout construction, supervisors and site supervisors will settle on choices about work to be attempted at specific times depending on the accessibility of the essential assets of work, materials, and hardware. Without coordination among these fundamental data sources, the development cycle will be wasteful or stop through (Hanna et al. 2002).

Materials and Methods

The study followed the utilization of the mixed design strategy utilizing the qualitative exploration just as the quantitative technique to acquire better experiences and a superior comprehension of the ideas and factors under investigation. As per Aramo (2013), a mixed strategy is an exploration plan in that a specialist gathers, investigates, and joins subjective and quantitative information into one research. The design of mixed strategy as shown in Figure 1, ensures verification of collecting and analyzing qualitative and quantitative data at the same time. The quantitative strategy depended on the utilization of a particular survey. A survey was utilized in this study to gather information on change orders on construction projects in Oman occupy a growing problem for construction companies. The qualitative method was an interviews with experts in Omani construction companies. Two statistical methods were utilized in the investigation of the information got, SPSS v24 for the survey and Constant Comparative Method for interviews.

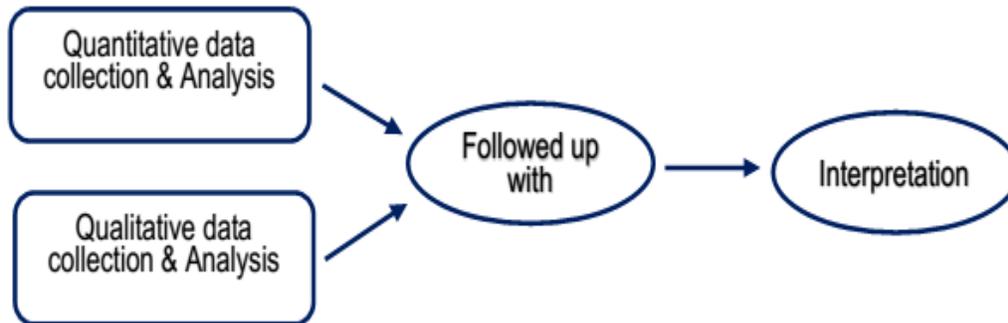


Figure 1.1: Mixed Design (Creswell and Guetterman, 2012)

Sample Size Determination

To calculate the size of sample from population can be done through the following formulae:

$$\text{Sample Size} = \frac{\frac{Z^2 \times p(1-p)}{e^2}}{1 + \left(\frac{Z^2 \times p(1-p)}{e^2 N}\right)}$$

Hence:

- N= the final estimation of target size of population
- e= Margin of error (the applicable for this study is at 5%)

z = Z score or SD (standard normal deviate) that at 95% confidence level
 p = the estimated population amount that obtained a long process of estimation (the applicable for this study is at 50%).

$$\text{Hence the needed size of sample} = \frac{\frac{1.96^2 \times 0.5(1-0.5)}{0.05^2}}{1 + \left(\frac{1.96^2 \times 0.5(1-0.5)}{0.05^2 \times 500}\right)} \sim 215 \text{ replies}$$

Results

Qualitative Research Findings

Interviews in scientific research are one of the most important tools for effectively contributing to providing accurate and in-depth information for research. Interviews were conducted with three engineers with experience in the field of work to discuss the problem of this research and find solutions that limit or mitigate the occurrence of change orders in future projects.

What are the change orders in construction projects in Oman?

This question was directed to engineers to define the change orders that occur in construction projects, as the occurrence of changes and errors in projects is something that is inevitable, especially large projects that include a large number of engineers and a lot of documents. These changes may be positive for the interest of the project and to avoid concluding a new contract.

“It is the substance disturbance to the project that is not liked by client. It is the additional cost for the contractor (new job). It is an increase of budget amount of the project (Eng. 1)”.

“Change order is simply defined as an order issued to the Contractor with a change in the original drawings or scope of work or specifications of a construction project (Eng. 2)”

What are the impact of change orders to the projects in Oman?

The answers to this question were different. Despite this, the main impacts remain cost and time. They delay the completion of projects in a timely manner, and may affect the progress of work or delay other activities.

“The impact of change orders to the projects can be positive or negative depending on the nature of the change orders. For example, if the Client suddenly decides to delete the whole swimming pool from the backyard. This is positive in a way that the project can be completed earlier with some cost savings. On the other hand, it can also be negative if he decides to add that swimming pool into the original scope of work, so that the project would be completed late with cost overrun (Eng-2)”.

“The effects of change orders listed as: Increase in the project cost, Increase in duration, Delay in completion schedule, Additional money for contractor and Disputes between owners and contractor (Eng-3)”.

Who is the responsible of change orders occur?

All engineers agreed in their answers that all parties (owner, consultant, and contractor) are responsible for the occurrence of change orders and all have a role in that according to the type of change orders.

“It could be from all parties, some time there are missing detail in the design result in change order or client decided to add to project other items or mistake from contractor may result also to change order (Eng-1)”.

“This depends on the nature of change orders. For instance, if it is a design error or an unforeseen risk or diversion of some hidden utilities, etc. Consultant is always responsible for designing errors. Contractor is fully responsible for unjustified construction delays. Client can be responsible if he always keeps on adding some new works (Eng-2)”.

How can we avoid the occurrence of change orders in projects?

Those involved in the various ministries and companies in the public and private sectors must put in place more stringent laws and regulations to reduce differences through proper planning, accurate designs and obtaining very clear requirements from the beginning to the end of the project, the following are the engineers' suggestions to reduce and limit this problem:

“The design and BOQ shall be +95% correct by giving more time to the right/suitable designers/consultants to do good work and time for review thereafter to clarify any missing or unclear design points. Appoint the right contractor to execute the project. This will minimize the VOs (Eng-1)”.

“Change orders could be avoided through proper planning and designing. The purpose of the project should be very clear at the planning stage. Budget must be carefully monitored from time to time. If possible, there should be a risk assessment report to follow and act accordingly during the execution of the project. Effective communication system should be there among the concerned parties for exchanging information and updates. Some advanced technologies like AR & VR or BIM or value engineering and analysis can be utilized if necessary. At the end, it is almost impossible to totally avoid variation orders in construction projects (Eng-2)”.

“Established process up front to prevent unauthorized change orders and other disputes as the project progresses and will ultimately minimize impacts to the schedule and budget. Provide a clear statement of work. Also, eliminate change orders resulting from incomplete design (Eng-3)”.

Quantitative Research Findings

The results of the descriptive analysis indicate that, a total of 215 had participated in this survey; of which 79.7% of them were males and remaining 20.3% were females. (Table 1.1) shows the descriptive analysis of the research sample profile.

Table 1.1 the descriptive analysis

Variables	Category	Results	
		F	%
Gender	Male	88	40.9
	Female	127	59.1
Nationality	Omani	206	95.8
	Non-Omani	9	4.2
Age Group	20-29 years old	41	19.1
	30-39 years old	145	67.4
	40- 49 years old	26	12.1
	>= 50 years old	3	1.4
Education	High School	13	6.0
	University	148	68.8
	Master	51	23.7
Primary area of woke	PhD	3	1.4
	Design	51	23.7
	Construction	62	28.8

Work experience	Operation	47	21.9
	Maintenance	16	7.4
	Other	39	18.1
	1-5 years	66	30.7
	6 -10 years	75	34.9
	11-20 years	64	29.8
	More than 21 years	10	4.7
Work description	Client	127	59.1
	Consultant	54	25.1
	Contractor	34	15.8

The table below shown the factors that lead to the occurrence of change orders in Oman. In this part, respondents were asked to rate the aforementioned factors to clarify the extent of their agreement or disagreement with them as follows: (1- Strongly Agree, 2- Agree, 3-Neutral, 4- Disagree, 5- Strongly disagree). The results mentioned in the table indicate that the change in the specifications obtained the highest percentage of 44.7% with agree option, while the same factor got the lowest rate of 0.9% in strongly disagree option. In addition, the highest mean is 2.68 for the factor of weather conditions and the factor of change in design and drawing get the lowest mean with 1.85. The highest SD for the factor of financial problems 1.167 and the lowest SD is 0.889 for the factor of change in design and drawing.

Table 1.2: The factors that lead to the occurrence of variation orders in Oman

	Factors	1	2	3	4	5	Mean	SD
1	Change in Design and Drawing	39.1	43.7	12.1	3.3	1.9	1.85	.889
2	Change in Specifications	37.2	44.7	11.2	6.0	0.9	1.89	.895
3	Financial Problems	32.1	26.5	24.7	12.6	4.2	2.30	1.167
4	Weather conditions	15.8	28.8	34.0	14.0	7.4	2.68	1.124
5	Lack of experience of the project implementing agency	28.4	38.6	20.5	11.2	1.4	2.19	1.015
6	Unavailability of project materials in the market	20.5	28.8	23.7	23.3	3.7	2.61	1.158
7	Poor Workmanship	22.8	30.7	24.2	19.5	2.8	2.49	1.127
8	Change in government regulations	21.9	33.5	25.1	16.7	2.8	2.45	1.092
9	Technology change	20.5	29.3	32.1	15.3	2.8	2.51	1.067
10	Equipment Resource	20.5	30.2	32.6	13.5	3.3	2.49	1.063

As shown in Table 1.3 below 74% of the participants confirmed that the client is the main reason for changing the scope and it is the highest percentage in this part. Errors and omissions in design had the lowest 2.3% attributable to other people involved in the project. In addition, the highest mean is 2.53 for the Logistic delays and the change of scope get the lowest mean with 1.37. The highest SD for replacement of materials or procedures .939 and the lowest SD is .604 for Errors and omissions in design.

Table 1.3: the responsible of the causes of change order

No.	Causes of change order	Client	Consultant	Contractor	Other	Mean	SD

1	Change of scope	74.0	18.1	5.1	2.8	1.37	.710
2	Errors and omissions in design	16.3	70.7	10.7	2.3	1.99	.604
3	Design complexity	27.0	54.9	15.3	2.8	1.94	.731
4	Financial and Decision Management	56.3	21.4	18.1	4.2	1.70	.909
5	Logistic delays	13.5	23.7	59.1	3.7	2.53	.772
6	Delay in completion and increase project cost	20.5	19.1	56.7	3.7	2.44	.856
7	Replacement of materials or procedures	34.4	23.3	38.1	4.2	2.12	.939
8	Quantification errors	14.4	47.4	32.6	5.6	2.29	.781

As is evident in the diagram, the relationship between the job description and the impact of change orders on the high cost of the project through 3 parties, where each side has its opinion. The figure shows that all parties agreed that change orders have a significant impact on the high cost of the project. 66.5% of client responders argued that increase in project cost acts as major impact of variation orders on construction projects. However, 2.3% obtained no impact about it

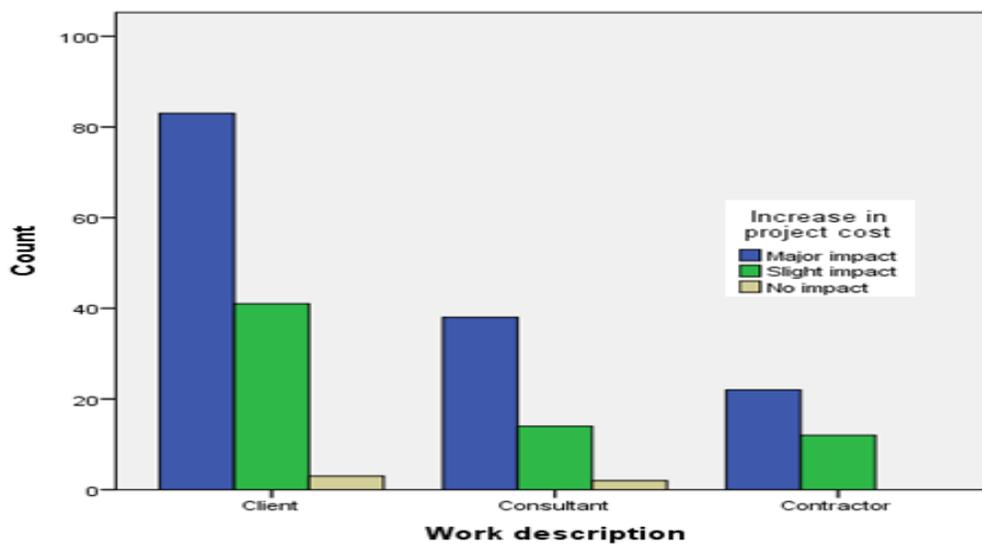


Figure 1.2 Work description

Conclusion

This section sums up the results of the examination and presents large numbers of outstanding discoveries, ends, and proposals that can assist all gatherings engaged with construction projects to improve and build up their own acts of controlling change orders. A portion of the proposals for other further examinations is introduced. As a rule, the destinations have been accomplished, a few outcomes were finished up, and numerous activities have been suggested. These ends and proposals are will have liked to improve the capacity of Oman construction parties in practices of the change order and to add an incentive for the construction industry explores in Oman. it was discovered that the owner of the project began to change arrangements due to financial problems, and changes in Pledge or Extension Plan. There are three justifications for this: The first one is that owner was not engaged with the plan advancement. Moreover, the owner did not understand the plan. Second, the owner may lack the ability to follow the plan and understand the drawings. The third is only variation as a top priority with negative effects not being evaluated at the same time in terms of changes. The consultant considers as the second main source that leads to orders in the construction projects. They affect because of mistakes and exclusions in plans, changes in specifications of the project, and differences found

in the agreement archives after winning the bid. The owner and consultant additionally creating change orders for subbing a portion of the works, materials, or strategies. This may happen because of new materials opening up on market, or because of changes in determinations. The impact of change orders on projects in Oman, many factors are affected by 66.5% of the respondents said that the increase in the project cost acts as a major effect of change orders on construction projects as shown. In addition, delays in the completion schedule and improvement in quality standards were significantly affected. Both time and cost overwhelm considered as major fundamental impacts being noted for change arrangements; an expansion in task length and extra installments for contractual workers is viewed as a result of changes. The questions between gatherings to the agreement and debasement of work efficiency are a significant worry here. The nature of work generally is not influenced through changes. The change orders can be avoided through appropriate planning and design. And also by using advanced technologies to reduce the occurrence of errors.

The current circumstance of management of the change order in Oman should be enhanced and improved. It could be limited if appropriate arranging occurred through including all construction bodies before the allocation of adequate budget, allocation of adequate time, close coordination, clear scope, and well communication is needed consistently, particularly in the stage of design.

Recommendations

Based on the findings of this research, the study recommends:

1. The owner's interest in the design phase and good and accurate planning of the requirements of the project in order to avoid modification during the implementation phase, which leads to an increase in the cost and the duration of the project.
2. The consultant must present the work plan accurately, in a clear and understandable manner, and include drawings, specifications and bill of quantities that are identical with each other.
3. The owner, the consultant, and the contractor should not rely entirely on the newly appointed engineers to avoid the shortages and errors that may appear during the implementation and thus reduce the changes to a minimum.
4. Coordination between all engineers and project workers in various disciplines (architectural, civil, electrical, mechanical and others), and it is important to understand and clarify the terms of the contract between all parties, in order for the construction projects to contain a large number of files and documents.
5. Choosing those with experience, technical and administrative ability from engineers to manage the project, so that the administration is more effective and easy to deal with any variables without resorting to variation orders.
6. Both the client and the consultant must follow up the project up-to-date with the contractor, and alert him in case of errors.

Suggestions

1. There should be an organization that annually evaluates all consultants and contractors and places them in different categories, because some consultants and contractors are given projects far above their capabilities and this is one of the main reasons for change orders, in other words some consultants only follow the client's instructions without giving a specialized technical opinion.
2. Omani engineers must not work in the government after their graduation, they must first work in a contracting or consulting company for a period of 2-3 years, then they can be allowed to work in the government sector, as the lack of knowledge and management skills of the client often leads to such effects and they must the

client is able to set up the scope of work so that there is no chance of loopholes that the consultant or contractor could use for change orders to occur.

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